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NOTES: Section 4.5 – Solve Quadratic Equations by Finding Square Roots

Goals: #1 - I can write square root expressions in simplest radical form by simplifying and rationalizing the denominator.

#2 - I can solve quadratics in the form $ax^2 + c$ by finding square roots.

Homework: Lesson 4.5 Worksheet

Warm Up:

1. Factor the following expressions:

   a. $8r^2 + 6r - 5$

   $8 \cdot -5 = -40$

   $10 \quad -4 = 6$

   $8r^2 - 4r + 10r - 5$

   $4r(2r-1) + 5(2r-1)$

   $\boxed{(2r-1)(4r+5)}$

   b. $9m^2 + 30mn + 25n^2$

   $\downarrow \quad \downarrow \quad \downarrow$

   $(3m)^2 \quad 2(3m \cdot 5n) \quad (5n)^2$

   $\boxed{(3m+5n)^2}$

2. Solve the following equation.

   a. $5x^2 + x - 4 = 0$

   $5 \cdot -4 = -20$

   $5 \quad -4 = 1$

   $5x^2 + 5x - 4x - 4 = 0$

   $5x(x+1) - 4(x+1) = 0$

   $(x+1)(5x-4) = 0$

   $x + 1 = 0$

   $\boxed{x = -1}$

   $5x - 4 = 0$

   $5x = 4$

   $\boxed{x = 4/5}$

Review: Simplify the expression.

1. $\sqrt{80}$

   $= \sqrt{16} \cdot \sqrt{5}$

   $= \boxed{4\sqrt{5}}$

2. $\sqrt{6} \cdot \sqrt{21}$

   $= \sqrt{126}$

   $= \sqrt{9} \cdot \sqrt{14}$

   $= \boxed{3\sqrt{14}}$

3. $\sqrt{\frac{7}{16}}$

   $= \frac{\sqrt{7}}{\sqrt{16}}$

   $= \boxed{\frac{\sqrt{7}}{4}}$

Notes:

Recall some properties of square roots.

- Product Property: $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$
- Quotient Property: $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

Perfect Squares:	4	9	16	25	36	49	64	81	100	121	144

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Example #1: Simplify the expression.

1. $3\sqrt{20} \cdot \sqrt{40}$

$= 3\sqrt{800}$

$= 3 \cdot \sqrt{100} \cdot \sqrt{4} \cdot \sqrt{2}$

$= 3 \cdot 10 \cdot 2 \cdot \sqrt{2}$

$= \boxed{60\sqrt{2}}$

2. $\sqrt{180}$

$= \sqrt{36} \cdot \sqrt{5}$

$= \boxed{6\sqrt{5}}$

3. $\sqrt{\frac{11}{25}}$

$= \frac{\sqrt{11}}{\sqrt{25}}$

$= \boxed{\frac{\sqrt{11}}{5}}$

4. $\sqrt{7} \cdot \sqrt{35}$

$= \sqrt{245}$

$= \sqrt{49} \cdot \sqrt{5}$

$= \boxed{7\sqrt{5}}$

Exploration #1: Work with a partner. Simplify the expression.

1. $\sqrt{\frac{17}{12}}$

$= \frac{\sqrt{17}}{\sqrt{12}} \cdot \frac{\sqrt{12}}{\sqrt{12}}$

$= \frac{\sqrt{204}}{12} = \frac{\sqrt{4} \cdot \sqrt{51}}{12} = \frac{2\sqrt{51}}{12} = \boxed{\frac{\sqrt{51}}{6}}$

2. $\sqrt{\frac{6}{5}}$

$= \frac{\sqrt{6}}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$

$= \boxed{\frac{\sqrt{30}}{5}}$

Notes:

When we get a radical ($\sqrt{\ }$) symbol in our denominator, we need to rationalize the denominator.

- $\sqrt{a} \rightarrow$ multiply by: $\sqrt{a}$

Examples: $\frac{6}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{6\sqrt{5}}{(\sqrt{5})^2} = \boxed{\frac{6\sqrt{5}}{5}}$

radical in denominator? Nope!

- $a + \sqrt{b}$ or $a - \sqrt{b} \rightarrow$ multiply by: conjugate

$a + \sqrt{b} \rightarrow a - \sqrt{b}$

Examples: $\frac{4}{5-\sqrt{2}} \cdot \frac{5+\sqrt{2}}{5+\sqrt{2}} = \frac{4(5+\sqrt{2})}{25+5\sqrt{2}-5\sqrt{2}-(\sqrt{2})^2}$

$= \frac{20+4\sqrt{2}}{25-4}$

$= \boxed{\frac{20+4\sqrt{2}}{23}}$

radical in denominator? Nope!

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Example #2: Simplify the expression.

1. $\sqrt{\frac{5}{2}}$

$= \frac{\sqrt{5}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$

$= \boxed{\frac{\sqrt{10}}{2}}$ ✓

radical in denominator? Nope!

2. $\frac{3}{7+\sqrt{2}} \cdot \frac{7-\sqrt{2}}{7-\sqrt{2}}$

$= \frac{21-3\sqrt{2}}{49-2}$

$= \boxed{\frac{21-3\sqrt{2}}{47}}$ ✓

You practice: Simplify the expression.

1. $\sqrt{\frac{19}{21}}$

$= \frac{\sqrt{19}}{\sqrt{21}} \cdot \frac{\sqrt{21}}{\sqrt{21}}$

$= \boxed{\frac{\sqrt{399}}{21}}$ ✓

2. $\sqrt{10} \cdot \sqrt{15}$

$= \sqrt{150}$

$= \sqrt{25} \cdot \sqrt{6}$

$= \boxed{5\sqrt{6}}$

3. $\frac{2}{4+\sqrt{11}} \cdot \frac{4-\sqrt{11}}{4-\sqrt{11}}$

$= \frac{2(4-\sqrt{11})}{16-11}$

$= \boxed{\frac{8-2\sqrt{11}}{5}}$

Example #3: Solve the equation.

1. $3x^2 + 5 = 41$

$-5 \quad -5$

$\frac{3x^2}{3} = \frac{36}{3}$

$x^2 = 12$

$\sqrt{x^2} = \sqrt{12}$

$x = \sqrt{4} \cdot \sqrt{3} = \boxed{\pm 2\sqrt{3}}$

2. $2x^2 - 15 = 65$

$+15 \quad +15$

$\frac{2x^2}{2} = \frac{80}{2}$

$x^2 = 40$

$\sqrt{x^2} = \sqrt{40}$

$x = \sqrt{4} \cdot \sqrt{10}$

$x = \boxed{\pm 2\sqrt{10}}$

You practice: Solve the equation.

1. $z^2 - 7 = 29$

$+7 \quad +7$

$\sqrt{z^2} = \sqrt{36}$

$\boxed{z = \pm 6}$

2. $\frac{3(x-2)^2}{3} = \frac{40}{3}$

$(x-2)^2 = \frac{40}{3}$

$\sqrt{(x-2)^2} = \sqrt{\frac{40}{3}}$

$x - 2 = \frac{\sqrt{40}}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}}$

$x - 2 = \frac{\sqrt{120}}{3}$

$+2 \quad +2$

$x = \frac{\sqrt{4} \cdot \sqrt{30}}{3} + 2$

$x = \boxed{\frac{\pm 2\sqrt{30}}{3} + 2}$

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Example #4: When an object is dropped, its height h (in feet) above the ground after t seconds can be modeled by the function $h = -16t^2 + h_0$ where h_0 is the object's initial height (in feet).

For a science competition, students must design a container that prevents an egg from breaking when dropped from a height of 50 feet. How long does the container take to hit the ground?

$$h = -16t^2 + \overset{h_0}{50}$$

$$0 = -16t^2 + 50$$

$$-50 \qquad\qquad -50$$

$$\frac{-50}{-16} = \frac{-16t^2}{-16}$$

$$3.125 = t^2$$

$$\sqrt{3.125} = \sqrt{t^2}$$

$$t \approx \boxed{1.77 \text{ seconds}}$$